Irrigated Lands Program

Draft Existing Conditions Report Executive Summary

The jurisdiction of the Central Valley Regional Water Quality Control Board (Central Valley Water Board) stretches from the Oregon border to the northern tip of Los Angeles County and includes all or part of 38 of the State's 58 counties. The three major watersheds delineated within this region are the Sacramento River Basin, the San Joaquin River Basin, and the Tulare Lake Basin (Figure ES-1). The three basins cover about 40% of the total area of the State and approximately 75% of the irrigated acreage (Central Valley Water Board 2002). Much of the surface water supplies in the Central Valley originate north of the Sacramento–San Joaquin River Delta (Delta), while much of the water use is south of the Delta. While there is plenty of surface water in the Sacramento River Basin to meet the present level of demand, surface water supplies in the San Joaquin River and Tulare Lake Basins are inadequate to support the present level of agriculture and other development. In these basins, imported water as well as groundwater resources are being used to meet existing water supply demands.

The crests of the Sierra Nevada Mountains on the east and the Coast Range and Klamath Mountains on the west border the Sacramento and San Joaquin River Basins. Surface waters from these two basins meet and form the Delta, which ultimately drains to the San Francisco Bay. Major groundwater resources underlie both river valley floors.

The draft Existing Conditions Report (ECR) has two central purposes. First, the information is intended to support the development of a number of alternative regulatory programs that can be used by the Central Valley Water Board to minimize the effects of discharges from irrigated agricultural land into waters of the state. Secondly, the information on current land uses and surface and groundwater quality in the Central Valley has been compiled to act as a baseline from which the environmental effects of various nonpoint source (NPS) regulatory control programs can be evaluated. The information collected to support these two purposes includes:

A comprehensive survey of readily available and relevant digital coverage for the entire Central Valley in a geographic information systems (GIS) format:

- topography,
- land use cover,
- water bodies,

- watershed boundaries,
- political boundaries, and
- major roadways.

A comprehensive study of all existing information related to water quality observations within each of the watersheds:

- general watershed parameters (acreage, land uses, major tributaries, flows, etc.),
- status of water quality conditions as listed in Section 303(d) of the Clean Water Act (CWA) (impaired water body list),
- constituents (wastes and/or pollutants that affect water quality) of concern, and
- discharge pathways and sources of wastes and/or pollutants (to the extent known).

A general description of groundwater conditions in the Central Valley Water Board's jurisdictional area:

- general watershed parameters (acreage, land uses, major tributaries, flows, etc.),
- impaired status of groundwater basin,
- constituents (wastes and/or pollutants that affect water quality) of concern, and
- discharge pathways and sources of wastes and/or pollutants (to the extent known).

Information regarding the current understanding of management practices employed by managers of irrigated lands and wildlife management areas is also provided. The information on management practices focused on what proven management practices are available to land managers, including an effort to interview a subset of land managers regarding what practices were being used.

The information in this draft ECR provides the basic physical and regulatory setting information needed to prepare an Environmental Impact Report. Preparation of the draft ECR has highlighted many of the challenges that may be encountered when moving forward. There are many land management practices that can reduce the influence irrigated agriculture and wetland management have on the quality of the waters of the state. Identification of specific sources of water quality impairment remains a challenge, and the implementation of management practices that specifically target improvement in water quality should proceed in tandem with identification of waste constituent sources.

Geography and hydrology are markedly different in the Sacramento River, San Joaquin River, and Tulare Lake Basins. Climate, water availability, and topography all play important roles in how irrigation water is applied and managed, including the discharge and reuse of irrigation return flows. Any regulatory irrigated lands program will need to be flexible enough to account for these differences. While the jurisdictional area of the Central Valley Water Board encompasses nearly 40% of the State, much of that area does not have impairments in water quality due to irrigated agriculture. It will be important to any program to be flexible enough to address new sources of pollution due to irrigation that may be detected in the future while focusing on specific areas of known pollution.

There are a number of laws and regulations that specifically provide guidance to the Central Valley Water Board on what must be contained in any NPS pollution control program. Whatever program is developed will need to be enforceable and hold dischargers accountable. Above all, the program that is implemented needs to contain provisions that will lead to an improvement in water quality and the attainment of beneficial uses for all water bodies of the state.

A summary of the information contained in the draft ECR is provided below.

Regulatory Setting

Surface water and groundwater quality are regulated in California through many laws, regulations, and ordinances administered by local, state, and federal agencies. Water quality regulation and permitting processes are designed to limit the discharge of wastes and/or pollutants to the environment in an effort to achieve the highest surface and groundwater quality, protect fish and wildlife and their habitats, and protect other beneficial uses (e.g., domestic and agricultural water supply and recreational resources). This section describes the regulations relevant to irrigated lands where water is applied for the purpose of producing corps. These crops include, but are not limited to, land planted to vineyard, row, pasture, field, and tree crops, commercial nurseries, nursery stock production, managed wetlands, rice production, and greenhouse operations with permeable floors that do not currently discharge under waste discharge requirements (WDRs), National Pollutant Discharge Elimination System (NPDES) permits, Municipal Separate Storm Sewer System permits, or other NPDES permits within the State of California.

Federal Programs Affecting Irrigated Lands Discharges

The CWA was established to regulate discharges of pollutants into waters of the United States. The CWA requires permits for all point source discharges, construction related discharges, and direct discharges of fill into or excavations from within a water of the United States, including wetlands.

Water runoff from irrigated cropland may contain pollutants that ultimately reach waters of the United States. Starting in the late 1980s, the U.S. Environmental Protection Agency (EPA) has led efforts to address polluted runoff, i.e., nonpoint sources that are responsible for the majority of water quality impairments in the nation. However, agricultural sources are not subject to CWA permits or other regulatory requirements under federal law. Under Section 319 of the CWA, the assessment and management of NPS pollution, including agricultural runoff, is the responsibility of the states.

Section 319 requires that each state produce an NPS assessment report that identifies the waters in that state that are impaired or threatened by NPS pollution and the sources contributing to the impairment. Under Section 319, the state must also identify the best management practices or measures to be used to control each pollution source identified (NPS management program) and specific criteria that define successful pollution control practices and measures. The EPA reviews and provides final approval for each state's NPS management program.

State Programs Affecting Irrigated Lands Discharges

The Porter-Cologne Water Quality Control Act (Porter-Cologne Act) establishes the State Water Resources Control Board (State Water Board) and divides the state into nine regions, each with a Regional Water Quality Control Board (Regional Water Board). The State Water Board and nine Regional Water Boards are the primary state agencies responsible for protecting the quality of the state's surface and groundwater resources.

The Porter-Cologne Act authorizes the State Water Board to draft state policies regarding water quality. In addition, the Porter-Cologne Act (Section 13263) authorizes the State Water Board and Regional Water Boards to issue individual and general waste discharge requirements, and to conditionally waive waste discharge requirements, for projects or activities that discharge waste that could affect the quality of the waters of the state. The Porter-Cologne Act requires that the State Water Board or the Regional Water Boards adopt water quality control plans (Basin Plans) for the protection of water quality. A Basin Plan must identify beneficial uses of water to be protected, establish water quality objectives for the reasonable protection of the beneficial uses, and establish a program of implementation for achieving the water quality objectives.

Central Valley Regional Water Quality Control Board Interim Conditional Waiver Program

On March 26, 1982, the Central Valley Water Board adopted Resolution No. 82-036, "Waiving Waste Discharge Requirements For Specific Types Of Discharge." Resolution No. 82-036 listed 23 categories of waste discharges, including irrigation return flows and storm water runoff from agricultural lands, and the conditions required to comply with the waiver. This waiver had conditions, but due to insufficient resources, verification that dischargers were complying with conditions was not conducted, and thus Resolution No. 82-036 was largely a passive program.

In 1999, Senate Bill 390 was adopted and amended California Water Code section 13269, which authorizes the Regional Water Boards to conditionally waive waste discharge requirements. Water Code section 13269, as amended, stated that all waivers in place on January 1, 2000 would sunset January 1, 2003 unless the Regional Water Board renewed the waiver. This change in the law meant that Resolution No. 82-036, which included irrigation return flows and stormwater runoff from agricultural lands in the Central Valley, would sunset. Water Code section 13269 as amended included additional requirements not contained in previous law and it has subsequently been amended to add additional requirements for waivers. Among other conditions, renewed or new waivers may not exceed five years in duration, must include monitoring and reporting programs, and must be in the public interest. In addition, it authorized the State Water Board to issue waivers.

On December 5, 2002, the Central Valley Water Board adopted Resolution No. R5-2002-0201 and the associated conditional waiver of WDRs for discharges from irrigated lands. The conditional waiver was slated to terminate in two years. Public comment on the December conditional waiver was significant and came from a broad spectrum of interests. Additionally, Central Valley Water Board members had questions on certain aspects of the newly adopted waiver and directed staff to consider comments and questions, and synthesize this input into key issues, to analyze these issues, and provide options and recommendations that could address them. Modifications to the waiver were proposed in April 2003, and based upon further public comment and Central Valley Water Board direction, further modifications were proposed in June 2003.

On July 10, 2003, Resolution No. R5-2002-0201 was rescinded and on July 11, 2003, Resolution No. R5-2003-0105 was adopted by the Central Valley Water Board. Resolution No. R5-2003-0105 adopted two conditional waivers that were intended to remedy perceived procedural concerns and to clarify conditions contained in Resolution No. R5-2002-0201. Under Resolution No. R5-2003-0105, one conditional waiver is for Coalition Groups or other entities that form on behalf of individual Dischargers to comply with the California Water Code and the Central Valley Water Board Plans and Policies. The second conditional waiver was for individual dischargers. These conditional waivers were set to expire in December 2005.

On November 28, 2005, the Central Valley Water Board voted to extend these conditional waivers for six months. The purpose of the extension was to clarify a number of issues, including the rules pertaining to coalition groups’ membership lists and the definition of discharger.

California State Water Resources Control Board—Nonpoint Source Pollution Control Program

The California Water Code Section 13369 requires that the State Water Board in consultation with the California Coastal Commission and other appropriate agencies, prepare a detailed program for the purpose of implementing and enforcing the state's NPS management plan.

Before a Regional Water Board approves or endorses a specific NPS pollution control implementation program, the Regional Water Board must determine that there is a high likelihood the implementation program will attain the Regional Water Board's stated water quality objectives. In order to be approved or endorsed, the NPS pollution control implementation program must meet the requirements of the five key structural elements. Development of Elements 1 and 2 are the primary responsibility of those who are developing the implementation program. Elements 3 and 4 may require consultation with the appropriate Regional Water Board. Element 5 shall be developed by the Regional Water Board.

For implementation programs developed by non-regulatory parties, factors such as availability of funding, a demonstrated track record or commitment to NPS control implementation, and a level of organization and group cohesion that facilitates NPS control implementation are among the critical factors that must be taken into account. For regulatory programs, the availability of staff resources to administer the implementation may be a major concern.

A Regional Water Board implements enforcement of the NPS Pollution Control Program through an "...escalating series of actions that allows for the efficient and effective use of enforcement resources to: (1) assist cooperative dischargers in achieving compliance; (2) compel compliance for repeat violations and recalcitrant violators; and (3) provide a disincentive for noncompliance."

In cases of individual noncompliance, selective enforcement actions may be taken. In cases of third-party noncompliance, an effort to revise the third-party program is an alternative. Generally, prior to initiating major revisions to a program, informal contact with dischargers, group representatives, or other third parties, if any, will be attempted in order to redirect unsuccessful efforts. However, although the direction and efforts of a particular third-party program are being undertaken as a group effort, with group designated or accepted leadership, if the group or third-party fails to follow through on their commitments, any Regional Water Board enforcement action taken will be against individual dischargers, not the third-party.

Surface Water Quality

Organization and Elements

The Central Valley Region is divided into three major surface water basins: the Sacramento River Basin Watershed, the San Joaquin River Basin Watershed, and the Tulare Lake Basin Watershed (Figure ES-1). Each of these three basins is divided into subwatersheds delineated by the California Department of Water Resources (DWR) CalWater boundaries, or a hybrid of these boundaries if the hybrid was determined to be more accurate in defining the watershed

(Figures ES-2, ES-3, ES-4). The subwatersheds in each of the three basins are listed below.

Of the 30 subwatersheds that comprise the Sacramento River, San Joaquin River, and Tulare Lake Basins, 12 are listed as impaired due to agriculture. These 12 subwatersheds will be the focus of attention during development of the Irrigated Lands Program. All areas in the jurisdiction of the Central Valley Water Board are described in the draft ECR.

Sacramento River Basin

The Sacramento River Basin covers 27,210 square miles. The principal streams in the basin are the Sacramento River and its larger tributaries: the Pit, Feather, Yuba, Bear, and American Rivers to the east; and Cottonwood, Stony, Cache, and Putah Creeks to the west. Major reservoirs include Shasta, Oroville, and Folsom. Of the eight subwatersheds within the Sacramento River Basin, only one subwatershed is not listed as impaired from irrigated agriculture: the Upper Feather–Upper Yuba Subwatershed. Many of the subwatersheds within the Sacramento River Basin are listed as impaired for various heavy metals from resource extraction (Table ES-1 at end of summary). The subwatersheds of the Sacramento River Basin are:

1. Pit River Subwatershed
2. Shasta-Tehama Subwatershed
3. Butte-Sutter-Yuba Subwatershed
4. Upper Feather River–Upper Yuba River Subwatershed
5. Lake-Napa Subwatershed
6. Colusa Basin Subwatershed
7. Solano-Yolo Subwatershed
8. American River Subwatershed

San Joaquin River Basin Watershed

The San Joaquin River Basin covers 15,880 square miles. The principal streams in the basin are the San Joaquin River and its larger tributaries, including the Cosumnes, Mokelumne, Calaveras, Stanislaus, Tuolumne, Merced, Chowchilla, and Fresno Rivers. Major reservoirs include Pardee, New Hogan, Comanche, Millerton, McClure, Don Pedro, and New Melones. The San Joaquin River Basin is delineated into 12 subwatersheds. Of these 12, four are impaired for pollutants from irrigated agriculture (Table ES-2 at end of summary). The remaining basins are all in the upper elevations, typically above the valley floor. The subwatersheds in the San Joaquin River Basin are:

1. Delta-Mendota Canal Subwatershed
2. San Joaquin River Subwatershed
3. San Joaquin Valley Floor Subwatershed

4. Delta-Carbona Subwatershed
5. Ahwahnee Subwatershed
6. Mariposa Subwatershed
7. Upper Mokelumne River–Upper Calaveras River Subwatershed
8. Merced River Subwatershed
9. North Valley Floor Subwatershed
10. Stanislaus River Subwatershed
11. Tuolumne River Subwatershed
12. Cosumnes River Subwatershed

Tulare Lake Basin

The Tulare Lake Basin comprises the drainage area of the San Joaquin Valley south of the San Joaquin River and encompasses approximately 17,650 square miles. The valley floor makes up slightly less than one-half the total basin land area. The Kings, Kaweah, Tule, and Kern Rivers, which drain the west face of the Sierra Nevada Mountains, provide the bulk of the surface water supply native to the basin. Major reservoirs are Pine Flat, Kaweah, Success, and Isabella. Imported surface water enters the Basin through the San Luis Canal/California Aqueduct System, Friant-Kern Canal, and the Delta-Mendota Canal. Of the 10 subwatersheds in the Tulare Lake Basin, only one subwatershed is impaired from irrigated agriculture (Table ES-3 at end of summary). This subwatershed comprises the entire valley floor and is called the South Valley Floor Subwatershed. The subwatersheds of the Tulare Lake Basin are:

1. Kings River Subwatershed
2. Kaweah River Subwatershed
3. Kern River Subwatershed
4. South Valley Floor Subwatershed
5. Grapevine Subwatershed
6. Coast Range Subwatershed
7. Fellows Subwatershed
8. Temblor Subwatershed
9. Sunflower Subwatershed
10. Southern Sierra Subwatershed

General Sources of Information

Surface Water Quality Data Collection and Methods

Collection of resources and data for surface water quality descriptions was accomplished by using various state and federal agency websites, water quality reports from various water quality coalitions, and other hard copy reports. Most of the surface water information came from existing reports. Because this draft ECR covers such a large geographical area, however, information to assess a particular watershed was often insufficient. In those cases, best professional judgment and technical hydrological experience were used in the analysis.

Many types of data for surface water analysis are available from government agencies [e.g., DWR, U.S. Geological Survey (USGS), Bureau of Reclamation] that routinely measure river flow, temperature, salinity, and other water quality parameters. Different agencies have collected data during various time periods, at different stations and with different parameters. These data are stored in various public and private databases operated by multiple agencies. This makes it difficult for stakeholders, agencies, or interested persons to access the full range of available data. Each type of data must be individually downloaded, processed, compiled, and compared.

Agency databases have different sets of procedures for downloading data. Some databases offer web-based retrieval, and others are stored on a compact disc (CD) (e.g., USGS and EPA). Some databases have interactive maps, while others allow only text or number searches for station names or identification numbers, respectively. Without a map it is difficult to identify station locations or names. Some databases are not publicly viewable and must be accessed through individual agency staff. In short, each database has its own accessibility features and constraints. This section identifies the sources of information and the techniques and methods associated with the data collection.

California Data Exchange Center

The California Data Exchange Center (CDEC) (http://cdec.water.ca.gov) is maintained by DWR, through the Division of Flood Management. It contains current and historical flow, water quality, and meteorological datasets for all of California. Users locate individual stations through a user-friendly map interface. Once the desired stations are located, a user may download one parameter from one station at a time, and the same limitations apply to downloading 3 or 4 years of hourly or 15-minute data at a time. After the data sequence is displayed on the screen, the user may select to save it to a file, or select a spreadsheet program to open it directly.

United States Geological Survey

The USGS maintains a database of current and historical flow and water quality data from many flow and water quality stations in California. These data can be accessed on the Internet at <http://water.usgs.gov/data.html>, as well as on a CD database product that is updated annually by a commercial vendor (Hydrosphere Data Products). This same vendor has a CD product with the EPA water quality database, called STORET. However, it is important to note that sometimes data between stations do not cross over between the website and the Hydrosphere product.

The USGS website has current and historical flow and water quality (i.e., grab sample) datasets. Hourly or 15-minute flow, stage, electrical conductivity (EC), and temperature data are available in the real-time portion of the database. Stations can be selected by state, station name, identification number, period of record, etc. Once a station is selected, individual parameters can be saved in a tab-separated file and then opened in a spreadsheet and error-checked. This USGS website is one of the more user-friendly database interface and retrieval systems available.

Bay Delta and Tributaries Project

Like the CDEC, the Bay Delta and Tributaries Project (BDAT) website (http://baydelta.water.ca.gov/index.html) is maintained by DWR. It consists of a database of water quality and meteorological datasets provided by more than 50 organizations. Although a map-based user interface to select data by location is being developed, data locations must currently be specified by location or ID code. This means that the user must already know the locations that are desired. Once a station is selected, the desired parameter(s) can be downloaded as an Excel file and then opened on the user's computer.

Land Use Data Collection and Methods for Subwatershed Boundaries

Derivation of Subwatershed Boundaries

Subwatershed boundaries were derived from the California Interagency Watershed Map of 1999 (CalWater 2.2.1). Updated in May 2004, CalWater 2.2.1 is the State of California's working definition of watershed boundaries, beginning with the division of the state's 101 million acres into ten Hydrologic Regions (HRs). Each HR is progressively subdivided into six smaller, nested levels: the Hydrologic Unit (HU—major rivers), Hydrologic Area (HA—major tributaries), Hydrologic Sub-Area (HSA), Super Planning Watershed (SPWS), and Planning Watershed (PWS). At the PWS level, where implemented, polygons range in size from approximately 3,000 to 10,000 acres.

With the exception of the Sacramento Basin, subwatershed boundaries were derived for the current project by using HU boundaries. Where applicable, HUs were lumped into regions with similar hydrology and land use characteristics. All boundaries in each subwatershed boundary dataset, including the Sacramento Basin, were derived from some level of CalWater 2.2.1, whether it was HU, HSA, or PWS.

The San Joaquin River Basin Watershed was also derived from CalWater 2.2.1 boundaries. However, some of the subwatersheds were combined to reduce the amount of redundancy in the delineations. Tulare Lake Basin Watershed boundaries also used CalWater 2.2.1 and were not altered.

Compilation of California Department of Water Resources Spatial Data

Jones & Stokes obtained the most current data available for each county covered under the jurisdiction of the Central Valley Water Board. Data were downloaded from the DWR Land and Water Use website (http://www.landwateruse.water.ca.gov/basicdata/landuse/digitalsurveys.cfm). For each basin (Sacramento, San Joaquin, Tulare), countywide data were aggregated into one dataset and then checked for matching edges; sliver polygons were repaired where necessary. Slivers were converted to the nearest land use classification where easily discernable. In ambiguous cases, they were classified as native vegetation. These sliver errors at county boundaries accounted for less than 0.035% by area within each basin (0.017% for Central Valley Region as a whole).

Supplemental Spatial Data (California Department of Forestry and Fire Protection, Fire Resources Assessment Program Vegetation)

There are several counties within the Central Valley Region for which DWR land use spatial data are incomplete or unavailable. In order to represent the entire Central Valley Water Board jurisdiction, the DWR land use data have been combined with the California Department of Forestry and Fire Protection (CDF) Fire Resources Assessment Program (FRAP) GIS layer (Multi-source Land Cover Data v02_2). This GIS dataset was chosen from many available sources because it has the broadest and most complete coverage of California, as well as having been peer reviewed and well documented. Readers are encouraged to visit the FRAPVEG site (http://frap.cdf.ca.gov/projects/frap_veg/index.html), which has detailed documentation on methods, links to sites with the source data used in FRAPVEG, and an update schedule.

The FRAPVEG dataset uses the California Wildlife Habitat Relationships (CWHR) system classification, which is different from the DWR classification system because it focuses on land cover rather than land use. In order to develop uniform calculations and maps for this report, the FRAPVEG GIS data were reclassified to more closely represent the DWR land use classes (Table ES-4 below).

Table ES-4. Reclassification of FRAPVEG Classes to DWR Land Use Types

FRAPVEG—Whr10Name	DWR Reclassification
Agriculture	Pasture
Barren/Other	Barren
Conifer	Native Vegetation
Desert	Native Vegetation
Hardwood	Native Vegetation
Herbaceous	Native Vegetation
Shrub	Native Vegetation
Urban	Urban
Water	Water Surface
Wetland	Wetland*

* Classification does not exist in DWR Land Use Data.

Calculations and Statistics

All calculations were performed using ESRI ArcGIS 9.1. A wide variety of geoprocessing tools were used to compile and analyze the data for this report, including *Merge*, *Intersect*, and *Erase*. All areas were calculated using *Summarize* or *Frequency* on tabular data and converted to appropriate units using Microsoft Excel.

Coordinate System

All spatial data are stored in Geodatabase format using the Teale Albers projection, NAD 1983 datum. For more information on the parameters of this coordinate system, visit <http://gis.ca.gov>.

Groundwater

Organization and Elements

The discussion of groundwater quality in each basin is organized by groundwater basin and subbasin. The groundwater basins within the Sacramento River, San Joaquin River, and Tulare Lake Basins of the Central Valley have been delineated using the boundaries contained in DWR Bulletin 118. Figures ES-5 through ES-8 show the basins and subbasins boundaries.

Each subbasin is discussed individually. The subbasin sections include a general physiographic and hydrogeologic description that includes information about groundwater recharge and discharge mechanisms, subsurface lithology, and groundwater bearing zones. To the extent available, the sections also include information about land use, water agencies and purveyors; the status of groundwater level changes; and any ordinances that may affect groundwater supply or quality. Data regarding groundwater quality has been included to the extent available for nutrients, pesticides, salinity, trace elements, and drinking water constituents of concern.

The available water quality data is discussed in the context of agricultural irrigation-related processes affecting the distribution and concentration of individual constituents. This includes description of possible discharge pathways for waste constituents, a description of land and water management practices that may affect groundwater quality, and the adequacy of the available data establishing baseline conditions for the subbasin. The groundwater quality descriptions are organized as follows. Large subbasins in the Sacramento Valley are discussed first in alphabetical order, followed by the small basins peripheral to the Valley in alphabetical order.

General Sources of Information

Sources of information for each subbasin include primarily reports and data from the DWR, California Department of Pesticide Regulation (DPR) and USGS. Specifically, land use data came from the DWR land use surveys conducted periodically throughout California. DWR 2004 Bulletin 118 was the primary source of information for subbasin hydrogeologic and physiographic descriptions. Several USGS reports provided information about concentrations of constituents in several basins. Recent USGS reports from the National Water Quality Assessment Program provided information about probable processes affecting groundwater quality in specific areas of the various basins.

DPR's Ground Water Protection Program determines where and how pesticides are polluting groundwater, identifies areas sensitive to pesticide pollution and develops mitigation measures to prevent that movement. DPR also adopts regulations and conducts outreach to carry out those mitigation measures. The measures are designed to prevent continued movement of waste constituents to groundwater and to prevent problems before they occur in other areas.

Other literature was reviewed and cited that provided understanding about agriculturally related processes affecting groundwater quality in general and for specific subbasins. This included peer reviewed journal articles and preliminary data and reports from the Groundwater Ambient Monitoring Assessment (GAMA) Project funded by the State Water Board. Reports were obtained from the State Water Board website that were helpful in understanding processes and travel times for groundwater to reach well screens for specific areas.

The USGS has recently completed a comprehensive sampling of groundwater in the Sacramento River Basin. However, this information has not yet been reviewed for this report. In the draft ECR, we outline general concepts and understanding of processes affecting groundwater quality in the various groundwater basins.

The primary groundwater constituents of concern related to agriculture discussed in the draft ECR, and the agriculturally related sources are listed in Table ES-5.

Table ES-5. Constituents of Concern

Constituent of Concern	Agricultural Source
Nutrients—primarily nitrate but may include nitrites and ammonia	Organic and chemical fertilizers, animal wastes, natural sources
Pesticides and degradation products	Crop applications
Salt—primarily as electrical conductivity and total dissolved solids	Evaporation from shallow water table and evapotranspiration of soil water, fertilizers, irrigation water, natural soil salinity, animal wastes
Trace elements (cadmium, copper, lead, nickel, zinc, selenium, arsenic and boron)	Fertilizers, irrigation water and natural sources
Organic carbon and disinfection byproduct precursors	Mobilization of soil organic matter and plant residues due to cultivation and irrigation
Microorganisms	Animal wastes

Groundwater Quality Summary

Recent studies as part of the GAMA Program provide some insight about the physical processes affecting waste constituent movement in Sacramento River Basin groundwater. The primary objective of the GAMA Program is to assess the water quality and to predict the relative susceptibility to pollution of groundwater resources throughout the state of California.

The results of the investigations reported here are consistent with conclusions drawn in the GAMA Program of relatively localized evidence of groundwater pollution due to irrigated agriculture in the Sacramento Basin. This also holds true for detections of pollution in the San Joaquin and Tulare Lake Basins as well. The key groundwater quality problems are in the areas of most intensive agriculture in the Sacramento Valley Basin, specifically subbasins in which rice cultivation occupies a significant percentage of the land use indicate potential groundwater quality issues related to movement of pesticides and nitrates. The key groundwater quality problems of the San Joaquin and Tulare Basins are also in the areas of most intensive agriculture, including areas of high dairy incidence. In addition, most of these areas tend to have pockets of relatively dense urban development, which can contribute to groundwater pollution.

Pesticide detections in groundwater in the Sacramento River, San Joaquin River, and Tulare Lake Basins are generally limited to a small number of compounds

(DPR 2003). These detections are related to physical and chemical properties of soils and the specific compounds, water management, and spatial and temporal variability of pesticide application and soil-water processes and properties. Data on transport of pesticides in groundwater highlights additional issues due to legacy pesticides that will need to be addressed during formulation of the Irrigated Lands Program. There are also difficulties in assessing the effects of groundwater pollution based on the relatively long period of time before pesticides used on irrigated agriculture begin to be detected in groundwater.

Irrigated Lands Management Practices

Agricultural management practices, best management practices and management measures are all various ways of describing how growers and other responsible parties pursue stated management objectives. In some cases, a practice or group of practices is pursued solely to lower production costs. In other cases, practices are implemented to address a specific objective, such as a reduction in storm water discharge that is external to the grower's operation.

Actions taken to prevent or reduce impacts to water quality include physical and operational (management and policy) changes as well as educational efforts. Physical changes include the modification of irrigation and drainage systems at both the on-farm and district level. Typically, infrastructure improvements are accompanied by operational or management changes. At the district level, operational changes include implementation of delivery policies that enable more flexible on-farm use and restrictions on return flows and drainage. At the farm level, there are a great number of actions that can be implemented to reduce effects on water quality and these are discussed in further detail in the draft ECR.

The draft ECR includes a discussion of the constituents of concern and then addresses known and potential management practices that can potentially affect these constituents. In addition, there is a review of the status of management practice information from the Coalition Groups and ongoing state agency-level grant, research and information programs.

Regarding wetlands, the draft ECR is organized by subbasin within each of the Central Valley watersheds. For each subbasin there is a general discussion about the private wetlands and a detailed discussion about the state and federal wetlands. There is considerably more pertinent information available for the wetlands managed by public agencies than for the private wetlands or the agricultural areas. The disproportionate level of available information appears to be due to the fact that private landowners generally do not collect or may not feel comfortable releasing this type of information.

Water Quality Constituents

Improving water quality through management practices is based on reducing or eliminating constituents that impact beneficial uses. The constituents that are addressed vary by watershed but are categorized as follows.

- **Sediment**—Transported and deposited particles or aggregates derived from rocks, soil or biological material. There are two primary concerns for sediment: its ability to bind chemicals, and the physical impacts caused by deposition.
- **Pesticides**—Natural or synthetic chemicals used to kill pests and unwanted vegetation.
- **Nutrients**—Natural or synthetic elements or compounds that are essential materials for organism growth and development.
- **Native**—Mobilization of natural compounds resulting from the use of land and water resources. In the Central Valley the primary native constituents of concern include boron, selenium, dissolved organic carbon and salinity.

The responsibility to track, monitor and regulate waste constituents that could affect water quality falls on several state and federal agencies. The main agencies include DPR, the State Water Board and its nine Regional Water Boards, and the EPA. The DPR, through regulating pesticide sales and use and fostering reduced-risk pest management, protects human health and the environment. The State Water Board under Section 303(d) of the CWA, is required to develop a list of impaired surface water bodies. The State Water Board establish priority rankings for water bodies on the lists, and the Regional Water Boards develop action plans, called total maximum daily loads, to improve water quality.

In 2003 the DPR listed 354 active ingredients applied in pesticides. This listing covers all pesticides used in California for any purpose, including irrigated agriculture, and shows the total amount used. In addition to the listing, there are links for product information, research and use trends.

The State Water Board lists water bodies that are impaired for beneficial use by pollution and publishes them on the 303(d) list. For 2002, the Central Valley list included about 124 impairments that are potentially caused by irrigated agriculture. The main pesticide constituents of concern and the crops they are primarily applied to are listed in Table ES-6. In addition to pesticides, the 303(d) List provides impairments caused by native constituents, nutrients and temperature.

Table ES-6. Pesticides Listed on the CWA Section 303(d) List That Are Commonly Used in Agricultural Production in the Central Valley of California

Constituent	Application period	Persistence	Application method	Physical Description	Flow Paths Affected	Pasture	Alfalfa	Sugar Beet	Field	Rice	Truck	Tomato	Orchard	Grains	Vines	Cotton	Citrus Olives
Azinphos-methyl	Organophosphate insecticide and acaricide	Half life in soil of 44–68 days and not readily soluble in water	Typically liquid application	Insoluble	Surface water return	No	No	No	No	No	Yes	Yes	Yes	No	No	Yes	Yes
Diazinon	Dormant spray in orchards and during growing season on other crops	Half life in soil of 14–28 days	Typically liquid application	Soluble	Surface or Groundwater return	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Chlorpyrifos	Dormant spray in orchards and during growing season on other crops	Half life in soil of 60–120 days and not readily soluble in water	Typically liquid application	Insoluble	Surface water return	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Methyl Parathion	Post emergence organophosphate insecticide	Half life in soil of 5 days (reported 1–30) and in water of 8–38 days	Dust, emulsifiable concentrate, ULV liquid, and wettable powder formulations	Soluble	Surface or Groundwater return	No	No	No	No	No	No	No	No	No	No	No	No
Carbofuran	Post emergence carbamate pesticide	Half-life in soil of 30–120 days	Liquid and granular formations, but granular formations are banned in the U.S. since 1994	Soluble	Surface or Groundwater return	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No
Malathion	Post emergenceorgano-phospate insecticide	Half life in soil of 1–25 days, air 1.5 days and water 7–21 days	Emulsifiable concentrate, wettable powder, dustable powder, and ULV liquid formations	Soluble	Surface or Groundwater return	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Group A	Predominantly as pre- and post emergent organochloride insecticides	Soil half life ranges from 21 days to 15 years)	Predominantly applied as liquid	Insoluble	Surface water return												

Implementation of Management Practices

Each constituent has unique chemical and physical properties and responds differently to biological activity; therefore, constituents can move and remain effective in different ways. These properties—volatility, adsorption, persistence and solubility—aid in determining which management practices will be used.

Based on their properties, constituents can move from the place of application in three basic ways—moving with surface water runoff and entrained soil particles, moving through percolation into the groundwater, and moving with air flow as drift. Constituents in runoff and adsorbed to sediment can impact receiving waters. Factors that affect the movement of constituents to surface waters include the timing of rainfall or irrigation following an application, slope, and the type of soil covering. Constituents can impact groundwater either directly or indirectly. Direct or point source impacts occur due to site-specific spills or preparation areas. Indirect or nonpoint-source impacts occur due to deep percolation on areas where the constituent is applied or from surface water flows to groundwater.

In general, the movement of constituents from the place of application to receiving water is through water management actions. Two primary actions lead to increased surface runoff; district operations and surface irrigation methods. To improve district operations, investments are made in regulating reservoirs, canal automation, interceptor systems and increased labor. These actions give a water supplier greater control over its operations and allows the end user to better match their crop water needs with the available supply. Although district improvements are not necessarily implemented to improve water quality they do have a direct impact on the ability for the end user to manage their system to reduce impacts to water quality. Similarly, end users are investing in technologies that utilize district improvements and provide greater control over the use of water. These technologies generally result in higher uniformity that in turn reduces the impacts to water quality from nutrients and pesticides. In addition, the higher level of management used with these systems typically results in less surface runoff.

Crop type, physical setting, and economics drive the selection and implementation of management practices used to support production systems. For a given crop rotation the physical setting, primarily water availability and the slope of the land are major drivers in selecting the type of on-farm irrigation and drainage system to use. The selection of other practices such as cover cropping, nutrient and pesticide management, harvesting and cultivation are driven by economics. County level agricultural extension offices typical provide publications that cover crop specific management practices.

After a review of documents, web searches and multiple phone conversations, it was apparent that there is very little quantitative or qualitative information regarding ongoing water quality-related management efforts. The information that is readily available is primarily written guidance on appropriate management practices based on cropping, cultural practices and irrigation water management. Given there are over 200 crops grown in the Central Valley with most crops amenable to several different types of production systems, the combination of management practices is significant and potentially daunting.

Guidance information regarding management practice is available in numerous formats from a multitude of sources. Information is available for site-specific issues such as reduction of erosion in the Yolo Basin or alternative strategies for application of annual dormant spray on tree crops. Other information is broad reaching such as the use of pressurized irrigation systems over surface irrigation methods. The reader should note that in some instances management practices could also be considered a treatment process.

Table ES-1. Sacramento River Basin Watershed

Subwatershed	Watershed	Pollutant	Source	TMDL Priority	Estimated Affected Size
Pit River Subwatershed	West Squaw Creek (below Balaka Mine)	Cadmium Copper Lead Zinc	Resource Extraction	Low	2 miles
	Pit River	Nutrients Organic Enrichment/ Low Dissolved Oxygen Temperature	Agriculture Grazing	Low	123 Miles
	Fall River	Sedimentation/Siltation	Agriculture Grazing, Silviculture	Low	8.6 Miles
	Horse Creek (Rising Star Mine to Shasta Lake)	Cadmium Copper Lead Zinc	Resource Extraction	Low	0.52 Miles
	Little Backbone Creek	Acid Mine Drainage Cadmium Copper Zinc	Resource Extraction	Low	0.95 Miles
	Lake Shasta (where West Squaw Creek Enters)	Cadmium Copper Zinc	Resource Extraction	Low	20 Acres
Shasta Tehama	Clover Creek	Fecal coliform	Agriculture Grazing	Low	11 miles
	Little Cow Creek	Cadmium Copper Zinc	Resource extraction (abandoned mines)	Low	1.1 miles
	Sac River (Keswick dam to Cottonwood Creek	Unknown toxicity	Source Unknown	Low	15 Miles
	Sac River (Cottonwood Creek to Red Bluff)	Unknown toxicity	Source Unknown	Low	16 Miles
	Sac River (Red Bluff to Knights Landing)	Unknown toxicity	Source Unknown	Low	82 Miles
	Sac River (Knights Landing to the Delta)	Diazinon Mercury Unknown Toxicity	Agriculture Resource Extraction Source Unknown	High Medium Low	16 Miles

Subwatershed	Watershed	Pollutant	Source	TMDL Priority	Estimated Affected Size
Butte - Sutter - Yuba	Sutter Bypass	Diazinon	Agriculture	Medium	19 miles
	Lower Bear River (below Camp Far West Reservoir)	Diazinon	Agriculture	Medium	21 miles
	Butte Slough	Diazinon	Crop-Related Sources	Medium	8.9 miles
	Feather River	Diazinon	Agriculture and Urban Runoff/ Storm Sewers	High	42 miles
		Group A Pesticides	Agriculture	Medium	42 miles
		Mercury	Resource Extraction (abandoned mines)	Medium	42 miles
		Unknown Toxicity	Source Unknown	Low	42 miles
	Engelbright Lake	Mercury	Resource Extraction (abandoned mines)	Medium	754 acres
	Sacramento Slough	Diazinon	Agriculture and Urban Runoff/ Storm Sewers	Medium	1.7 miles
		Mercury	Source Unknown	Low	1.7 miles
	Sacramento River (Knights Landing to the Delta)	Diazinon	Agriculture	High	16 miles
Colusa Basin	Sacramento River (Red Bluff to Knights Landing)	Unknown Toxicity	Source Unknown	Low	82 miles
	Lower Cache Creek (Clear Lake Dam to Cache Creek Settling Basin near Yolo Bypass)	Mercury	Resource Extraction (abandoned mines)	Medium	96 miles
		Unknown Toxicity	Source Unknown	Low	96 miles
	Bear Creek	Mercury	Resource Extraction	Medium	15 miles
	Sulphur Creek	Mercury	Resource Extraction (abandoned mines)	Medium	14 miles
	Harley Gulch	Mercury	Resource Extraction (abandoned mines)	Medium	6 miles
	Davis Creek Reservoir	Mercury	Resource Extraction	Low	163 acres
	Colusa Basin Drain	Azinphos-methyl	Agriculture	Medium	49 miles
		Cabofuran/Furadan	Agriculture	Low	
		Diazinon	Agriculture	Medium	
		Group A Pesticides	Agriculture	Low	
		Malathion	Agriculture	Low	

Subwatershed	Watershed	Pollutant	Source	TMDL Priority	Estimated Affected Size
		Methyl Parathion	Agriculture	Low	
		Molinate/Odram	Agriculture-irrigation tailwater	Low	
		Unknown Toxicity	Agriculture	Low	
Upper Feather - Upper Yuba	Little Grizzly Creek	Copper	Resource Extraction	Medium	9.4 Miles
		Zinc		Medium	
	Dolly Creek	Copper	Resource Extraction	Low	1.5 miles
		Zinc		Low	
	Kanaka Creek	Arsenic	Resource Extraction	Low	9.7 Miles
	French Ravine	Bacteria	Land Disposal	Low	1.7 Miles
	Combie Lake	Mercury	Resource Extraction	Medium	362 acres
	Camp Far West Reservoir	Mercury	Resource Extraction	Medium	1945 acres
	Upper Bear River	Mercury	Resource Extraction	Medium	10 Miles
	Deer Creek (Yuba County)	pH	Internal Nutrient Cycling	Low	4.3 Miles
	Humbug Creek	Copper	Resource Extraction	Low	2.2 miles
		Mercury	Resource Extraction	Low	
		Sedimentation/Siltation	Resource Extraction	Low	
		Zinc	Resource Extraction	Low	
Lake County	Lake Berryessa	Mercury	Resource Extraction	Low	19083 acres
	Cache Creek (from Clear Lake to Yolo Bypass)	Mercury	Resource Extraction (abandoned mines)	Medium	96 miles
		Unknown Toxicity	Source Unknown	Low	96 miles
	Harley Gulch	Mercury	Resource Extraction (abandoned mines)	Medium	6 miles
	Bear Creek	Mercury	Resource Extraction	Medium	15 miles
	Clear Lake	Mercury	Resource Extraction	High	40070 acres
		Nutrients	Source Unknown	Medium	40070 acres
	Clover Creek	Fecal Coliform	Agriculture-grazing and Other	Low	11 miles
	James Creek	Mercury	Resource Extraction (abandoned mines)	Low	6.3 miles
		Nickel	Resource Extraction (abandoned mines)	Low	6.3 miles

Subwatershed	Watershed	Pollutant	Source	TMDL Priority	Estimated Affected Size
Solano-Yolo	Sacramento River (Knights Landing to Delta)	Diazinon	Agriculture	High	16 Miles
		Mercury	Resource Extraction	Medium	
		Unknown Toxicity	Unknown Source	Low	
	Lower Putah Creek	Mercury	Resource Extraction and Source Unknown	Low	28 miles
American River Watershed	Sacramento River (From Knights Landing to Delta)	Diazinon	Agriculture-irrigation tailwater	High	16 Miles
		Mercury	Resource Extraction	Medium	
		Unknown Toxicity	Unknown Source	Low	
	Arcade Creek	Chlorpyrifos	Urban Runoff/ Storm Sewers	High	9.9 Miles
		Diazinon	Urban Runoff/ Storm Sewers	High	
		Copper	Urban Runoff/ Storm Sewers	Low	
	Morrison Creek	Diazinon	Urban Runoff/ Storm Sewers	High	21 Miles
	Natomas East Drain Canal (Downstream of Arcade Creek)	Diazinon	Agriculture-irrigation tailwater	Medium	3.5 Miles
		PCBs		Low	
	Natomas East Main Canal (Upstream of Arcade Creek)	PCBs	Agriculture-irrigation tailwater	Low	12 Miles
	Elder Creek	Diazinon	Agriculture-irrigation tailwater	High	11 Miles
		Chorpyrifos			
	Chicken Ranch Slough	Diazinon	Agriculture-irrigation tailwater	High	8 Miles
		Chlorpyrifos			
	Strong Ranch Slough	Diazinon	Agriculture-irrigation tailwater	High	6.4 Miles
		Chlorpyrifos			
	American River	Mercury	Resource Extraction	Low	27 Miles
		Unknown Toxicity	Unknown Source		
	Lower American River	Mercury	Resource Extraction (abandoned mines)	Low	27 miles
		Unknown Toxicity	Source Unknown		

Table ES-2. San Joaquin River Basin

Subwatershed	Watershed	Pollutant	Source	TMDL Priority	Estimated Affected Size
Delta-Carbona Subwatershed	Delta Waterways (Eastern Portion)	Chlorpyrifos		High	20,135 Acres
		Diazinon		High	
		DDT		Low	
		Group A Pesticides		Low	
		Mercury		Medium	
		Unknown Toxicity		Low	
	Delta Waterways (Stockton Ship Channel)	Chlorpyrifos		High	952 Acres
		Diazinon		High	
		DDT		Low	
		Group A Pesticides		Low	
		Mercury		Medium	
		Unknown Toxicity		Low	
		Organic Enrichment/ Low Dissolved Oxygen		High	
	Turning Basin	Pathogens		Medium	3.3 miles
		Dioxin		Low	
		Furan Compounds		Low	
		PCBs		Low	
	Delta Waterways (Western Portion)	Chlorpyrifos		High	22,904 Acres
		Diazinon		High	
		DDT		Low	
		Group A Pesticides		Low	
		Mercury		Medium	
		Unknown Toxicity		Low	
		EC		Medium	
	Old River (SJR to DMC)	DO		Low	15 Miles
	Middle River	DO		Low	9.7 Miles
	Smith Canal	Organic Enrichment/ Low Dissolved Oxygen		Low	2.4 Miles
		Pathogens		Low	
		Organo-phosphorus Pesticides		Medium	

Subwatershed	Watershed	Pollutant	Source	TMDL Priority	Estimated Affected Size
	Lower Calaveras River	Organic Enrichment/ Low Dissolved Oxygen		Low	5.8 Miles
		Pathogens		Low	
	Five Mile Slough (Alexandria Place to Fourteen Mile Slough)	Chlorpyrifos		Medium	1.6 Miles
		Diazinon		Medium	
		Organic Enrichment/ Low Dissolved Oxygen		Low	
		Pathogens		Low	
	Mormon Slough (Commerce Street to Deep Water Channel)	Organic Enrichment/ Low Dissolved Oxygen		Low	0.93 Miles
		Pathogens		Medium	
	Mosher Slough (Downstream of I-5)	Chlorpyrifos		Medium	1.3 Miles
		Diazinon		Medium	
		Organic Enrichment/ Low Dissolved Oxygen		Low	
		Pathogens		Low	
	Mosher Slough (Upstream of I-5)	Pathogens		Low	3.5 Miles
	Dunn Creek (Mt. Diablo Mine to Marsh Creek)	Mercury		Low	0.7 Miles
		Metals		Low	
	Marsh Creek (Dunn Creek to Marsh Creek Reservoir)	Metals		Low	11 Miles
	Marsh Creek (Marsh Creek Reservoir to San Joaquin River)	Mercury		Low	10 Miles
		Metals		Low	
	Marsh Creek Reservoir	Mercury		Low	278 Acres
Ahwahnee Subwatershed	None	None	None	None	None
Mariposa Subwatershed	None	None	None	None	None
Upper Mokelumne River–Upper Calaveras River Subwatershed	None	None	None	None	None
Merced River Subwatershed	None	None	None	None	None

Subwatershed	Watershed	Pollutant	Source	TMDL Priority	Estimated Affected Size
North Valley Floor Subwatershed	Camanche Reservoir	Copper		Low	7,389 acres
		Zinc		Low	
	Mokelumne River	Copper		Low	29 miles
		Zinc		Low	
	Avena Drain	Ammonia		Low	6.4 miles
		Pathogens		Low	
	Lone Tree Creek	Ammonia		Low	15 miles
		BOD		Low	
		EC		Low	
	Temple Creek	Ammonia		Low	10 miles
		EC		Low	
	Mormon Slough (Stockton Diverting Canal to Commerce Street)	Pathogens		Medium	5.2 miles
	Walker Slough	Pathogens		Medium	2.3 miles
Stanislaus River Subwatershed	None	None	None	None	None
Tuolumne River Subwatershed	Don Pedro Reservoir	Mercury	Resource Extraction (abandoned mines)	Low	11,056 acres

Table ES-3. Tulare Lake Bed

Subwatershed	Watershed	Pollutant	Source	TMDL Priority	Estimated Affected Size
Kings River Subwatershed	None	None	None	None	None
Kaweah River Subwatershed	None	None	None	None	None
Kern River Subwatershed	None	None	None	None	None
South Valley Floor Subwatershed	Lower Kings River (Island Weir to Stinson and Empire Weirs)	Electrical conductivity Molybdenum Toxaphene	Agriculture	Low	36 miles
	Panoche Creek (Silver Creekt to Belmont Ave.)	Mercury Sedimentation/ Siltation Selenium	Resource extraction Agriculture Agriculture-grazing, highway, road/bridge construction	Low	18 miles
Grapevine Subwatershed	None	None	None	None	None
Coast Range Subwatershed	Panoche Creek (Silver Creekt to Belmont Ave.)	Mercury Sedimentation/ Siltation Selenium	Resource extraction Agriculture Agriculture-grazing, highway, road/bridge construction	Low	18 miles
	San Carlos Creek	Mercury	Resource Extraction/Acid Mine Drainage	Low	5.1 Miles
Fellows Subwatershed	None	None	None	None	None
Temblor Subwatershed	None	None	None	None	None
Sunflower Subwatershed	None	None	None	None	None
Southern Sierra Subwatershed	None	None	None	None	None